H-W HANDBOOK of REFRACTORY PRACTICE



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TAR TREATMENT OF BASIC BRICK

For many years, brick manufacturers have used tar or pitch to treat basic refractories. Tar limits penetration by metal, slag and furnace fumes into the brick.

For **tar-bonded** brick, the manufacturer mixes grains of refractory raw material with tar, shapes the mix and cools the brick. In service, the tar turns to carbon and inhibits penetration, but tar-bonded brick have limited load-bearing capability.

Tar-bonded and tempered brick are manufactured in the same way, then heated to 500 or 600°F (260 to 316°C) to drive off some of the volatiles. The heat treatment makes the tempered brick stronger, more refractory, before it goes into service.

For **tar-impregnated** brick, the manufacturing process begins with brick pressed into shape and burned. The manufacturer evacuates air from the pores of the brick in a vacuum chamber, then permits tar to replace the air in the brick. Tar-impregnated brick are the strongest — most refractory — of the three classes of tar-bearing basic refractories.

METAL-ENCASED BRICK

Many brands of basic brick — either fired or chemically-bonded — are sold and used encased in steel. Harbison-Walker originally developed the first of its METALKASE brands many years ago.

In service, the metal case oxidizes and reacts with the brick a short distance into the hot face of the furnace wall or roof. The reaction produces a strong bond, highly refractory, with good resistance to mechanical and thermal peeling. Metal-encased brick, generally, have superior resistance to spalling.

Metal-encased basic brick have accounted for improved practice and service in many industrial furnaces. They are successfully used in open-hearth and electric steel melting furnaces, copper and nickel reverberatory furnaces and rotary kilns. Metal casings have made the use of basic brick practical in many roof constructions. In fact, a large proportion of all basic brick sold are metal-encased.

Four Metal Cases Designed for Brick

METALKASE® brick are basic brick encased in sheet steel on three or four sides. Firm adherence of the steel casing to the refractory is assured by the tight grip of indentations in the casing.

METALKASE®XXP® brick are metal-encased basic brick with two internal plates. These brick are formed under high pressure and are available in various compositions in standard sizes as well as suspended arch and other shapes.

EXKASE® brick are METALKASE basic brick providing expansion allowance through a crease in the metal casing. EXKASE is used as a prefix with specific brand names, for example EXKASE NUCON 50.

TABKASE® brick are metal-encased brick with a stainless steel tab to give the brick additional vertical support when the tab is fastened to an overhead structural member. TABKASE brick are used for basic roof and wall construction. The TABKASE name, like all metal casing names, is always used in conjunction with a specific brand name, such as H-W TABKASE NUCON 60 brick.

BASIC BRANDS

CHROMEX™ Chemically-Bonded Chrome-Magnesite Brick A general purpose basic refractory, CHROMEX brick are chemically-bonded and offer considerable volume stability as well as resistance to spalling.

Primary Applications: Open-hearth furnaces, non-ferrous foundries and reheat furnaces; glass tank regenerators.

CHROMEX B™ Burned Chrome-Magnesite Brick A standard burned, chrome-magnesite brick, CHROMEX B provides volume stability at temperatures above 3000°F (1650°C). This brand also offers good resistance to thermal shock and a range of slags.

Primary Applications: General purpose burned basic. Open-hearth furnace uptakes, front wall piers and subhearth; soaking pit lower sidewalls; forging furnace bottoms; copper and nickel converters; copper refining furnace sidewalls; brass melting furnaces, sodium sulfide recovery boiler sidewalls and bottom; fiberglass tank stacks; shaft kilns.

CHROMEX BG™ Burned Chrome-Magnesite Brick These brick feature additional slag and corrosion resistance and the ability to stand up to oxidizing *or* reducing atmospheres. CHROMEX BG brick also provide good hot strength and resistance to thermal cycling.

Primary Applications: Glass tank regenerator walls, division walls, port necks and crowns; direct-fired fiberglass tank stack linings; copper converters and refining furnaces.

CHROMEX S™ Chemically-Bonded Chrome Brick A chemically-bonded chrome brick, CHROMEX S has high resistance to corrosion and slags, and considerably lower thermal conductivity than that of magnesite brick.

Primary Applications: Glass furnace regenerators and kraft recovery boilers.

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Primary Applications: Electric furnace sidewalls; glass tank regenerator walls, crown, rider arches, port neck segment and bottom checkers; direct-fired glass tank stacks; copper reverberatory and refining furnaces and converters; forging furnaces; soaking pit slaglines; argon-oxygen decarburizer vessels; open-hearth uptakes.

NUCON 60® Chrome-Magnesite Brick High-fired, direct-bonded basic brick of 60 percent magnesia content, NUCON 60 features excellent hot strength and corrosion resistance at steel-melting temperatures. NUCON 60 brand brick are made from pure periclase and beneficiated chrome ore.

Primary Applications: Electric furnace sidewalls and roofs; open-hearth roofs and walls; soaking pit slaglines; argon-oxygen decarburizer vessels; rotary kiln burning zones.

NUCON 80® Magnesite-Chrome Brick An 80 percent magnesia refractory, NUCON 80 offers the additional refractoriness — hot strength and resistance to erosion or corrosion by basic and iron slags — provided by the extra magnesia in its composition. It is an exceptionally dense, strong, direct-bonded brick.

Primary Applications: Electric furnace sidewalls and roofs; open-hearth walls; rotary kiln burning zones; glass tank checkers.

OXIBAK H® Magnesite Brick Outstanding hot strength and resistance to penetration by fluxing agents are features of OXIBAK H, a 96 percent magnesia refractory brick. OXIBAK H brand brick provide unusual resistance to oxidation-reduction reactions as well as slag attack.

Primary Applications: Basic oxygen furnace back-up linings; glass tank regenerator top and front pass checkers.

OXILINE B® Magnesite Brick High purity magnesite, high fired for strength at high temperatures, gives OXILINE B refractory brick the ability to withstand severe mechanical and thermal shock. OXILINE B, 95 percent magnesia, is tar-impregnated for lower permeability and superior resistance to slag in non-oxidizing atmospheres.

Primary Applications: Heavy duty basic oxygen furnace working linings; electric furnace slaglines, tapholes and troughs; open-hearth runners.

OXILINE CL® Magnesite Brick An economical tar-bonded 90 percent magnesia refractory for conventional operations, OXILINE CL resists atmospheric hydration during shutdown periods.

Primary Applications: Basic oxygen furnace linings.

OXILINE K® Magnesite Brick A high purity, 96 percent magnesia refractory brick, OXILINE K is tar-bonded and provides good resistance to slags with higher iron oxide content. It is used for furnace lining zones where burn-in strength is *not* required.

Primary Applications: Basic oxygen furnace linings.

OXILINE KL® Magnesite Brick These tempered, tar-bonded refractory brick are made from high purity magnesite — 96 percent magnesia. They are especially compounded to resist slags high in iron oxide and are used where burn-in strength is required.

Primary Applications: Basic oxygen furnace linings.

OXILINE LV® Magnesite Brick A tar-bonded 90 percent magnesia refractory brick tempered to provide additional strength, OXILINE LV is an atmosphere-stable refractory and is strong enough to be used in the corbel cone without metal supports.

Primary Applications: Basic oxygen furnace linings.

TOPEX S® Chemically-Bonded Magnesite Brick These refractory brick are 97.5 percent magnesia, chemically-bonded. Resistance to thermal shock and destructive atmospheres characterize Harbison-Walker's TOPEX S brick. Made of high purity crystalline magnesia, they resist erosion by solids in the atmosphere and corrosion by fluxing agents, even in atmospheres that fluctuate between oxidation and reduction.

Primary Applications: Glass tank regenerator checkers.

H-W®43-66 Chemically-Bonded Magnesite-Chrome Brick These brick are 60 percent magnesia, chemically-bonded. They are generally not used unless metal encased. Depending on the chemical requirements of the furnace, H-W 43-66 brick are less expensive and work as well as conventional burned magnesite brick. H-W 43-66 brick can withstand loads at temperatures up to 3025°F (1664°C).

Primary Applications: Suspended roofs of copper reverberatory furnaces.

H-W®4-67 Magnesite Brick High purity magnesite, high-fired for strength at high temperatures, gives H-W 4-67 the ability to withstand severe mechanical and thermal shock. H-W 4-67 brick, 95 percent magnesia, are tar-impregnated for lower permeability and superior resistance to slag in non-oxidizing atmospheres. H-W 4-67 brick feature a tar-free surface to permit better mortar joints.

Primary Applications: Basic oxygen furnace tank linings which may be exposed to the furnace atmosphere.

H-W®2-73 Chemically-Bonded Magnesite-Chrome Brick A chemically-bonded high-lime magnesia brick with 20 percent chrome ore, H-W 2-73 features high refractoriness and good resistance to steelmaking slags and abrasion.

Primary Applications: Electric furnaces.

H-W®31-73 Burned Magnesite-Chrome Brick A burned 80 percent high-lime magnesite and 20 percent chrome ore brick with high refractoriness make H-W 31-73 a good choice for severe wear areas of electric furnaces. H-W 31-73 brick provide compatibility with, and resistance to, steelmaking slags.

Primary Applications: Electric furnaces and rotary kiln burning zones.

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CASTOLAST® Gun Mix (H-W®27-75) This mix combines tabular alumina aggregate with a high strength, high purity calcium-aluminate binder. It has extremely high strength and chemical purity which allows it to withstand severe environments up to its maximum service temperature of 3300°F (1817°C).

Primary Applications: Ammonia reformers; combustion chambers; catalytic or naphtha reformer cyclones.

HARGUN® Gun Mix (H-W®25-75) A blend of superduty fireclay calcines and high purity calcium-aluminate binders with a 2800°F (1539°C) service temperature, HARGUN features high refractoriness and abrasion resistance.

Primary Applications: General maintenance.

HARGUN®BF Gun Mix (H-W®2-74) HARGUN BF Gun Mix combines selected superduty fireclay calcines with a high strength, high purity calcium-aluminate binder. It features excellent abrasion resistance, high refractoriness and a service temperature of 2800°F (1539°C).

Primary Applications: Blast furnace stack linings; incinerator linings; cyclones; rotary kilns; iron ore furnace preheat units; wind boxes; fluid catalytic cracking process transfer lines, risers, and slide valves.

TUFSHOT® Gun Mix (H-W®27-73) Composed of hard-fired fireclay and standard calcium-aluminate binders, TUFSHOT brand gun mix features a service temperature of 2400°F (1317°C), low permeability and good resistance to mechanical impact and abrasion.

Primary Applications: Boilers; incinerators; process heaters; stacks and breechings.

TUFSHOT®LI Gun Mix (H-W®30-73) This gun mix combines hard-fired fireclay aggregate with improved low iron calcium-aluminate binders. TUFSHOT Low Iron Gun Mix provides excellent strength and abrasion resistance throughout its 2600°F (1428°C) temperature range.

Primary Applications: Similar to TUFSHOT Gun Mix, but at higher service temperature.

Lightweight Gun Mixes

H-W® Lightweight Gun Mix 16 (H-W®13-75) Low density and a low coefficient of thermal conductivity make H-W Lightweight Gun Mix 16 the top insulator in the 1600°F (872°C) temperature range.

Primary Applications: Gunned substitute for block insulation.

H-W® Lightweight Gun Mix 20 (H-W®4-74) A combination of firm aggregate and high purity calcium-aluminate cement, H-W Lightweight Gun Mix 20 provides low density, a 2000°F (1094°C) service temperature and excellent back-up performance.

Primary Applications: Back-up insulation; low temperature gas ducts.

H-W® Lightweight Gun Mix 22 This blend of standard calcium-aluminate binders and lightweight aggregate, features uniform density and the strength for hot-face insulating applications up to 2200°F (1205°C).

Primary Applications: Back-up insulation for catalyst transfer lines and process furnace heaters.

One-Shot Gun Mixes

H-W®40-64 Gun Mix A combination of calcined clays, lightweight aggregates and improved calcium-aluminate cement, H-W 40-64 Gun Mix provides a service temperature of 2600°F (1428°C) and good strength and insulating value.

Primary Applications: Catalytic crackers; line equipment; boiler linings; ducts and exhaust lines; hydrocracking; stack breechings; and process heaters.

H-W®28-75 Gun Mix High temperature calcines, lightweight aggregate and high purity calcium-aluminate binders combine to give H-W 28-75 Gun Mix excellent refractoriness, good strength and good insulating properties up to 2900°F (1595°C).

Primary Applications: Similar to H-W 40-64 but for high service temperatures.

Hot-Shot Gun Mixes

HOTGUN™28 Gun Mix (H-W®29-63) A superduty fireclay gun mix, HOTGUN 28 features high refractoriness, good strength and extremely low rebound loss, with a service temperature of 2800°F (1539°C).

Primary Applications: General hot maintenance work.

HOTGUN™29 Gun Mix (H-W®7-68) This 70 percent alumina gun mix provides high refractoriness, good volume stability and good strength up to its 2900°F (1595°C) service temperature.

Primary Applications: Hot maintenance of secondary aluminum reverberatory furnaces and 70 percent alumina refractory linings.

KORUNDAL® Gun Mix A high purity, 90 percent alumina mix, KORUNDAL Gun Mix provides a 3100°F (1706°C) service temperature, excellent gunnability, and superior slag and corrosion resistance, along with good hot patching ability.

Primary Applications: Hot repair of iron induction furnaces, electric-arc furnace roofs and iron and steel ladles.

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GLOSSARY

Abrasion of Refractories: Wearing away of the surfaces of refractory bodies in service by the scouring action of moving solids.

Absorption: As applied to ceramic products, the weight of water which can be absorbed by the ware, expressed as a percentage of the weight of the dry ware.

Abutment: The structural portion of a furnace which withstands the thrust of an arch.

Acid-Proof Brick: Brick having low porosity and permeability, and high resistance to chemical attack or penetration by most commercial acids and some other corrosive chemicals.

Acid Refractories: Refractories such as silica brick which contain a substantial proportion of free silica and which when heated, can react chemically with basic refractories, slags and fluxes.

Aggregate: As applied to refractories, a ground mineral material, consisting of particles of various sizes, used with much finer sizes for making formed or monolithic bodies.

Air-Ramming*: A method of forming refractory shapes, furnace hearths, or other furnace parts by means of pneumatic hammers.

Air-Setting Refractories: Compositions of ground refractory materials which develop a strong bond upon drying. These refractories include mortars, plastic refractories, ramming mixes and gunning mixes. They are marketed in both wet and dry condition. The dry compositions require tempering with water to develop the necessary consistency.

Alumina: Al_2O_3, the oxide of aluminum; melting point 3720°F (2050°C); in combination with H_2O (water), alumina forms the minerals diaspore, bauxite and gibbsite; in combination with SiO_2 and H_2O, alumina forms kaolinite and other clay minerals.

Alumina-Silica Refractories: Refractories consisting essentially of alumina and silica, and including high-alumina, fireclay and kaolin refractories.

Amorphous: Lacking crystalline structure or definite molecular arrangement; without definite external form.

Andalusite: A brown, yellow, green, red or gray orthorhombic mineral; Al_2SiO_5. Specific gravity 3.1 - 3.2. Decomposes on heating, beginning at about 2460°F (1350°C) to form mullite ($Al_6Si_2O_{13}$) and free silica.

Anneal: To remove internal stress by first heating and then cooling slowly.

Arc: As applied to circles, any portion of a circumference, as applied to electricity, the luminous bridge formed by the passage of a current across a gap between two conductors or terminals.

*A.S.T.M. Standard Definitions C 71-57; or A.S.T.M. "Tentative Definitions" are used where applicable.

Arch, Flat: In furnace construction, a flat structure spanning an opening and supported by abutments at its extremities; the arch is formed by a number of special tapered brick, and the brick assembly is held in place by their keying action. Also called a jack arch.

Arch, Sprung: In furnace construction, a bowed or curved structure which is supported by abutments at the sides or ends only, and which usually spans an opening or space between two walls.

Arch, Suspended: A furnace roof consisting of brick shapes suspended from overhead supporting members.

Arch Brick: A brick shape having six plane faces (two sides, two edges and two ends), in which two faces (the sides) are inclined toward each other and one edge face is narrower than the other.

Asbestos: Commercially, any mineral which can be separated into flexible fibers.

Ash: The noncombustible residue which remains after burning a fuel or other combustible material.

Attrition: Wearing away by friction; abrasion.

Auger Machine: A machine for extruding ground clays in moist and stiffly plastic form, through a die by means of a revolving screw or auger.

Baddeleyite: A mineral composed of zirconia (ZrO_2). Specific gravity 5.8. Melting point 4890°F (2700°C).

Bagasse: The fibrous material remaining after the extraction of the juice from sugar cane.

Ball Clay: A highly plastic refractory bond clay of very fine grain, which has a wide range of vitrification and which burns to a light color. Often high in carbonaceous matter.

Basic Refractories: Refractories which consist essentially of magnesia, lime, chrome ore or mixtures of two or more of these and, when heated, can react chemically with acid refractories, slags and fluxes.

Bauxite: An off-white, grayish, brown, yellow, or reddish-brown rock composed of a mixture of various amorphous or crystalline hydrous aluminum oxides and aluminum hydroxides (principally gibbsite, some boehmite), and containing impurities in the form of free silica, silt, iron hydroxides, and especially clay minerals; a highly aluminous laterite.

Bauxitic Clay: A natural mixture of bauxite and clay containing not less than 47 percent nor more than 65 percent alumina on a calcined basis.

Bentonite: A kind of clay derived from volcanic ash and characterized by extreme fineness of grain. Its main constituent is the clay mineral montmorillonite. It is somewhat variable in composition and usually contains 5 to 10 percent of alkalies or alkaline earth oxides. One type has the capacity for absorption of large amounts of water, with enormous increase in volume.

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